A Reinforced soil retaining wall system and method of construction

FIELD OF THE INVENTION

The present invention relates to a reinforced soil retaining wall system and a method of construction of a reinforced soil retaining wall. The present invention further relates to a block used in the construction of a reinforced soil retaining wall and a length of strip reinforcement used in the construction of a reinforced soil retaining wall.

The present application claims priority from Australian provisional patent application 2004901725 filed on 1 April 2004, Australian provisional patent application 2004901789 filed on 5 April 2004, Australian provisional patent application 2004907121 filed on 15 December 2004 and Australian provisional patent application 2005900832 filed on 23 February 2005.

BACKGROUND TO THE INVENTION

Retaining walls are defined as any wall that restrains material on one side of a wall to maintain a difference in elevation. Nearby slopes, driveways, buildings, and tiered walls all represent potential loads on retaining walls. There are three main types of retaining walls: gravity walls, cantilever walls and reinforced soil walls. A retaining wall without soil reinforcement, where the weight of the blocks alone provides resistance to the load of the soil being retained, is referred to as a "gravity wall". Gravity retaining walls cost more money to install, which each block in the wall consisting of a mass of concrete or stone. Gravity walls rely upon their mass weight to retain the soil. Excavation of the soil behind a gravity wall has no effect on the structural strength of the wall. Cantilever walls are typically sheet pile structures which are driven into the soil and derive their support solely through the resistance the soil provides against rotation of the sheet pile under the weight of the soil being retained. One type of cantilever wall comprises a horizontal base section that is buried under the backfill with a stem section permanently connected to and extending vertically from the base section to form the wall. Cantilever walls rely on the weight of the backfill on the base section to keep the wall from tipping over.

The term "reinforced soil retaining wall" refers to a retaining wall that incorporates

substantially horizontal layers of soil reinforcement material buried under the soil being retained by the wall. One type of reinforced soil retaining wall comprises reinforcement in the form of steel mesh buried within the retained soil. The steel mesh anchors a concrete slab, steel sheet or rock filled wire basket which acts as the facing of the retaining wall, the facing being the structure that forms the front of the wall, usually oriented vertical or inclined. The facing prevents the soil from escaping from between the layers of reinforcement. Using the methods of the background art, the soil reinforcement must be added to all or most of the courses of blocks and some form of propping is required to prevent the facing from moving whilst the soil is compacted around the reinforcement.

The present invention was developed to overcome at least some of the abovementioned problems.

It will be clearly understood that, although a number of background art methods and/or publications are referred to herein, this reference does not constitute an admission that any of these methods or publications form part of the common general knowledge in the art, in Australia or in any other country. In the summary of the invention, the description and claims which follow, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a reinforced soil retaining wall system comprising:

a plurality of blocks arranged in courses above a base course to form a wall, the wall having a retained side and a dredge side, each block comprising a front face oriented in use towards the dredge side of the wall, a rear face spaced from said front face by a distance defining the depth of said block and oriented in use towards the retained side of the wall, a top surface, a bottom surface spaced from said top surface by a distance defining the height of said block, opposing side surfaces spaced from each other by a distance defining the width of said block, and a passage

extending through at least a portion of the height of the block and terminating in a first opening in the top or bottom surface, the passage and first opening configured to receive a first portion of a length of strip reinforcement; and,

a plurality of lengths of strip reinforcement for anchoring the wall, each length of strip reinforcement insertable within at least one of the plurality of blocks such that a first portion of the length of strip reinforcement is received within the passage of the block, a second portion of the length of strip reinforcement is arranged in coplanar alignment with the top or bottom surface of the block and a third portion of the length of strip reinforcement is arranged to extend outwardly from the rear face of the block and secured in position substantially perpendicular to the wall during backfilling and compaction.

The passage may be substantially vertically oriented relative to the top or base section of the block to maximize the pull out forces required to remove the length of strip reinforcement from the passage after it has been inserted.

Preferably each length of strip reinforcement is resiliently flexible.

For mortarless construction, the blocks may further comprise a guide slot extending from the first opening passage along the top or bottom surface of the block, the guide slot terminating at the rear face of the block and configured to house the second portion the length of strip reinforcement. The third portion of the length of strip reinforcement may be arranged in coplanar alignment with the top and or base surface of the blocks immediately prior to backfilling and compacting or may lie at an angle to the wall during backfilling and compacting. .

In one embodiment, the passage extends through the full height of the block from a first opening provided in the bottom surface of the block to a second opening provided in the top surface of the block which allows the length of strip reinforcement to be inserted through the passage from the first opening to the second opening with a fourth portion of the length of strip reinforcement arranged to extend outwardly from the rear face of the block to be secured in position substantially perpendicular to the wall during backfilling and compaction. The fourth portion may be arranged in general coplanar alignment with respect to the top or bottom face of the block away from the

wall immediately prior to backfilling and compaction to maximize resistance to pull-out forces.

Advantageously, the passage may be a cavity extending from the bottom surface to the top surface, the cavity configured to receive a quantity of ballast in the form of drainage aggregate or an impermeable material such as cast concrete or cement. The passage may be one of plurality of passages.

In one embodiment, the system further comprises one or more shear pins to resist sliding movement of a first course over an adjacent second course and may further comprise a drainage channel configured to direct moisture from the retained side of the wall towards the dredge side of the wall. The drainage channel is particular advantageous for use with clay soils to relieve any buildup of hydrostatic pressure on the retained side of the wall.

In another embodiment, the plurality of lengths of strip reinforcement are divided into a threaded section inserted into at least one block and a free section co-operatively associated with the threaded section and arranged to arranged to extend outwardly from the rear face of the block and be secured in position substantially perpendicular to the wall during backfilling and compaction.

In a further embodiment, the reinforced soil retaining wall system forms a lower section of a composite wall, the composite wall being divided a transition depth into an upper section and the lower section. The upper section may be a gravity or cantilever retaining wall. Using this embodiment, a soil reinforcement protection barrier may be placed at the transition depth in general coplanar alignment with the top uppermost course of blocks forming the lower section of the composite wall. The soil reinforcement protection barrier may be a concrete slab used to provide a physical indication of the transition depth or a thin sheet of plastic material used to provide a visual indication of the transition depth.

According to a second aspect of the present invention there is provided a method of construction of a reinforced soil retaining wall system, the system comprising a plurality of blocks arranged in courses above a base course to form a wall, the wall being

anchored by backfilling and compacting soil over a plurality of lengths of strip reinforcement operatively connected to at least a portion of the plurality of blocks laid in courses, the method of construction comprising the steps of:

a) providing a level surface for laying a course of blocks, each block comprising a front face, a rear face spaced from said front face by a distance defining the depth of said block, a top surface, a bottom surface spaced from said top surface by a distance defining the height of said block, opposing side surfaces spaced from each other by a distance defining the width of said block, a passage extending through at least a portion of the height of the block and terminating in a first opening in the top or bottom surface, the passage and first opening configured to receive a first portion of a length of strip reinforcement;

b) inserting a length of strip reinforcement into a block to be laid in the course such that a first portion of the length of strip reinforcement is received in the passage, a second portion of the length of strip reinforcement is arranged in coplanar alignment with the top or bottom surface of the block and a third portion of the length of strip reinforcement is arranged to extend outwardly from the rear face of the block;

c) positioning the block and the inserted length of strip reinforcement onto the level surface such that the rear surface of the block and the third portion of the length of strip reinforcement is directed towards the soil to be retained by the wall;

d) repeating step (a) to (c) until a required height for the retaining wall has been achieved; and,

e) anchoring the position of the third portion of the length of strip reinforcement by backfilling and compacting a quantity of soil behind the rear face of the block.

Step (e) may be conducted after step (c) after each course is completed or after the wall has been completed in a single backfilling operation.

For mortarless construction, each block further comprises a guide slot extending from the first opening along the bottom surface of the block and terminating at the rear face of the block, the guide slot being configured to accommodate the second portion the length of strip reinforcement. The third portion of the length of strip reinforcement may be arranged in coplanar alignment with the top and or base surface of the blocks immediately prior to step (e). In one embodiment the passage extends through the full

height of the block from a first opening provided in the bottom surface of the block to a second opening provided in the top surface of the block and step (b) comprises the step of inserting a length of strip reinforcement through the passage from the first opening to the second opening such that a fourth portion of the length of strip reinforcement is arranged to extend outwardly from the rear face of the block. For this embodiment, step (e) further comprises the step of anchoring the position of the fourth portion of the length of strip reinforcement by backfilling and compacting a quantity of soil behind the rear face of the block. The fourth portion may be arranged in general coplanar alignment with respect to the top or bottom face of the block away from the wall immediately prior to backfilling and compaction or arranged at an angle with respect to the wall.

In another embodiment, the passage is a cavity extending from the bottom surface to the top surface and the method further comprises the step of adding a quantity of ballast to the cavity after each block or each course of blocks has been laid. The ballast may be drainage aggregate or an impermeable material such as cast concrete.

The method of construction may further comprise the step of installing one or more shear pins to resist sliding movement of a first course over an adjacent second course.

In yet another embodiment, the plurality of lengths of strip reinforcement are divided into a threaded section inserted into at least one block at step (b) and a free section co-operatively associated with the threaded section and arranged to extend outwardly from the rear face of the block and be secured in position during step (e) substantially perpendicular to the wall during backfilling and compaction.

In one embodiment the reinforced soil retaining wall forms a lower section of a composite wall, the composite wall being divided a transition depth into an upper section and the lower section and the method further comprises the step of constructing a gravity or cantilever retaining wall to form the upper section of the composite wall. Using this embodiment, the method may further comprise the step of installing a soil reinforcement protection barrier at the transition depth in general coplanar alignment with the top uppermost course of blocks forming the lower section of the composite wall. The step of installing a soil reinforcement protection barrier may

comprise the step of laying a concrete slab.

According to a third aspect of the present invention there is provided a block for use in constructing the reinforced soil retaining wall system of the first aspect of the present invention. According to a fourth aspect of the present invention there is provided a length of strip reinforcement for use in constructing the reinforced soil retaining wall system according the method of the second aspect of the present invention.

According to a fifth aspect of the present invention there is provided a reinforced soil retaining wall system comprising:

a plurality of blocks arranged in courses above a base course to form a wall, the wall having a retained side and a dredge side, each block comprising a front face oriented in use towards the dredge side of the wall, a rear face spaced from said front face by a distance defining the depth of said block and oriented in use towards the retained side of the wall, a top surface, a bottom surface spaced from said top surface by a distance defining the height of said block, opposing side surfaces spaced from each other by a distance defining the width of said block;

a first plurality of sections of soil reinforcement for anchoring the wall to the backfill, the first plurality of sections of soil reinforcement arranged between adjacent courses of the wall and extending outwardly from the rear face of the blocks on the retained side of the wall; and,

a second plurality of sections of soil reinforcement for stabilizing a quantity of backfilled and compacted soil on the retained side of the wall, the second plurality of sections of soil reinforcement being spaced apart from the first plurality of sections of soil reinforcement and arranged to extend substantially perpendicular to the wall during backfilling and compaction.

The second plurality of sections of soil reinforcement may be spaced apart from the rear face of the wall, laid immediately adjacent thereto or be in abutting contact therewith.

In one embodiment, one or both of the first or second plurality of sections soil reinforcement is/are resiliently flexible. The length of the plurality of second sections of soil reinforcement depends on the particular application and may be equal to at least

60%, 70% or 80% of the height of the wall. It is advantageous for the plurality of second sections of soil reinforcement have a length that extends at least through the anticipated plane of rupture of the backfill which is again a function of a number of factors including the soil characteristics of the backfill and the properties of the wall itself.

One or both of the first or second plurality of sections of soil reinforcement may be planar, such as geomesh or take the form of elongated strips of strip reinforcement.

In one embodiment the first and second plurality of sections of soil reinforcement are arranged in horizontal coplanar arrangement with respect to each other. In another embodiment, the first plurality of sections of soil reinforcement are arranged in a first layer and the second plurality of sections of soil reinforcement are arranged in a second layer offset from the first layer.

One or both of the first or second plurality of sections of soil reinforcement may be arranged in coplanar alignment with the top and or base surface of one or more of the plurality of blocks immediately prior to backfilling and compacting. The second plurality of sections of soil reinforcement may equally be arranged at other heights.

In one embodiment, the blocks further comprise one or more cavities extending from the bottom surface to the top surface, the cavity configured to receive a quantity of ballast which may be drainage aggregate or an impermeable material such as cast concrete or cement mortar. For soils with poor drainage, the system may further comprise a drainage channel configured to direct moisture from the retained side of the wall towards the dredge side of the wall.

In another embodiment, the reinforced soil retaining wall system forms a lower section of a composite wall, the composite wall being divided a transition depth into an upper section and the lower section. The upper section may be a gravity or cantilever type retaining wall. Using this embodiment, a soil reinforcement protection barrier such as a concrete slab or sheet of plastic material may be placed at the transition depth in general coplanar alignment with the top uppermost course of blocks forming the lower section of the composite wall.

Where mortar is used to construct the wall, the first plurality of sections of soil reinforcement are fixedly held between adjacent courses of blocks using mortar. Alternatively for mortarless construction, the first plurality of sections of soil reinforcement are fixedly held between adjacent courses of blocks by gravity under the weight of the blocks forming the adjacent courses.

According to a sixth aspect of the present invention there is provided a method of construction of a reinforced soil retaining wall system, the system comprising a plurality of blocks arranged in courses above a base course to form a wall, the method of construction comprising the steps of:

a) providing a level surface for laying a course of blocks, each block comprising a front face, a rear face spaced from said front face by a distance defining the depth of said block, a top surface, a bottom surface spaced from said top surface by a distance defining the height of said block, opposing side surfaces spaced from each other by a distance defining the width of said block;

b) arranging a first plurality of sections of soil reinforcement for anchoring the wall to the backfill between adjacent courses of the wall whilst laying each course of blocks, the first plurality of sections of soil reinforcement being arranged to extend outwardly from the rear face of the blocks on the retained side of the wall;

c) laying each subsequent course until a required height for the retaining wall has been achieved;

d) arranging a second plurality of sections of soil reinforcement spaced apart from the first plurality of sections of soil reinforcement and arranged to extend during step (e) substantially perpendicular to the wall; and,

(e) backfilling and compacting a quantity of backfill behind the rear face of the blocks so as to anchor the position of the first and second plurality of sections of soil reinforcement.

Step (e) may be conducted after step (b) and prior to step (c) for each course of conducted after the wall has been completed. The second plurality of sections of soil reinforcement may be arranged during step (e) so as to be spaced apart from the rear face of the wall.

In one embodiment, the first and second plurality of sections of soil reinforcement are arranged in horizontal coplanar arrangement with respect to each other. Alternatively, the first plurality of sections of soil reinforcement are arranged in a first layer and the second plurality of sections of soil reinforcement are arranged in a second layer offset from the first layer.

One or both of the first or second plurality of sections of soil reinforcement may be arranged in coplanar alignment with the top and or base surface of one or more of the plurality of blocks immediately prior to backfilling and compacting.

In one embodiment, the blocks further comprise one or more cavities extending from the bottom surface to the top surface, the cavity configured to receive a quantity of ballast and the method further comprises the step of adding a quantity of ballast to the cavity after each block or each course of blocks has been laid. The ballast may be drainage aggregate or an impermeable material such as concrete or cement mortar.

The system may further comprise the step of installing one or more shear pins to resist sliding movement of a first course over an adjacent second course.

In yet another embodiment, the reinforced soil retaining wall forms a lower section of a composite wall, the composite wall being divided a transition depth into an upper section and the lower section and the method further comprises the step of constructing a gravity or cantilever retaining wall to form the upper section of the composite wall A soil reinforcement protection barrier may be installed at the transition depth in general coplanar alignment with the top uppermost course of blocks forming the lower section of the composite wall.

For mortared construction, the first plurality of sections of soil reinforcement may be fixedly held between adjacent courses of blocks using mortar. For mortarless construction, the first plurality of sections of soil reinforcement may be fixedly held between adjacent courses of blocks by gravity under the weight of the blocks forming the adjacent courses.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to facilitate a more detailed understanding of the nature of the invention several embodiments of the reinforced soil retaining wall system will now be described in detail, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a side cross-sectional view through a wall constructed according to a first embodiment of the reinforced soil system of the present invention using mortar to secure the position of the blocks and illustrating the arrangement of the courses of blocks and lengths of strip reinforcement anchoring the wall under backfilled and compacted soil;

Figure 2 (a) and 2 (b) each illustrate an isometric view of one of the blocks used to construct the wall of Figure 1 illustrating the position of the passage into which a length of strip reinforcement is inserted before the block is laid and the position of a guide slot for receiving a second portion of the a length of strip reinforcement so that blocks in adjacent course may sit flush relative to each other for use in the construction of a mortarless wall;

Figure 3 is a cross-section view through section A-A of the block of Figure 2 (a);

Figure 4 illustrates the block of Figure 3 with a length of strip reinforcement inserted therein;

Figure 5 is an isometric cross-sectional view through part of the wall showing a plurality of lengths of strip reinforcement threaded through the blocks;

Figure 6 is a partial isometric view of a wall for which two courses have been constructed showing the arrangement of the blocks and lengths of strip reinforcement prior to backfilling and compaction for a first embodiment of the present invention;

Figure 7 is an isometric view of a completed wall showing the arrangement of the blocks and lengths of strip reinforcement through two courses of blocks after backfilling and compaction for a first embodiment of the present invention;

Figure 8 is an isometric view of a block used in accordance with a second embodiment of the reinforced soil retaining wall system of the present invention;

Figure 9 is a cross-sectional view through section B-B of the block illustrated in Figure 8 showing the arrangement of the length of strip reinforcement inserted into the block;

Figure 10 is a partial isometric view of a wall for which two courses have been constructed showing the arrangement of the blocks and lengths of strip reinforcement prior to backfilling and compaction for a second embodiment of the present invention;

Figure 11 is a side cross-section view of a third embodiment of the present invention illustrating a composite wall having an upper section and a lower section;

Figure 12 is a side cross-section view of a fifth embodiment of the present invention showing an impermeable layer and drainage channel for retaining clay soils;

Figure 13 illustrates an alternative embodiment for use with clay soils in which the cavities of the blocks illustrated in Figures 8 and 9 are filled with drainage aggregate which forms the permeable layer;

Figure 14 is a partial isometric view of a completed wall constructed using a fourth embodiment of the present invention whereby the strip reinforcement is laid in sections; and,

Figure 15 is a partial isometric view of a reinforced soil wall system constructed using a first plurality of sections of soil reinforcement between courses and a second plurality of sections of soil reinforcement embedded in the backfilled soil and arranged in a spaced apart relationship relative to the first plurality of sections of soil reinforcement.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Particular embodiments of various aspects of the present invention are now described in the context of the construction of a single tiered straight retaining wall. It is to be understood that the various aspects of the present invention are readily adaptable to the construction of multi-tiered or curved retaining walls. The terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which this invention belongs. For the purposes of clarity, some of the terms as used throughout this specification are now defined.

The “dredge side” of a retaining wall is the side with the lower soil surface elevation. The “dredge line” is the term applied to the line of intersection between the soil surface

on the dredge side of the wall and the wall itself. The "retained side" of the retaining wall is the side with the higher soil surface elevation after backfilling. The term "backfill" refers to any type of material, typically soil that is placed on the retained side of the wall. The backfill that is placed behind a reinforced soil retaining wall is also referred to in the art as "reinforced soil". Loose backfill can add to the load on the retaining wall, allows water to collect, causes settlement problems and may not anchor soil reinforcement materials properly. Accordingly, all backfill is compacted to meet the requirements of prevailing local compaction standards, the term "compaction" referring to the application of mechanical force to reduce the compressibility of the backfill and mitigate the risk of future movement of the retaining wall.

"Drainage Aggregate" is free-draining, typically angular gravel of substantially coarse and uniform size used to expedite drainage of moisture. For best results, drainage aggregate should consist of a plurality of stone particles of sufficiently large and common size to cause voids to exist between them to allow the passage of the water and should not contain fine particles that may impede water flow.

A "course" is a horizontal layer of retaining wall blocks. The "base course" is the first layer of blocks typically placed on top of a leveled foundation. The "capping" is the last or top course of blocks which may be designed for decorative appeal. The capping is constructed using solid (as opposed to hollow) blocks to prevent the ingress of water into the retaining wall. The "bond" is the arrangement or pattern of blocks from course to course. A block that is centered over the vertical joint created by adjacent blocks in the preceding course is said to be laid using a "stretcher bond".

The term "geomesh" is used throughout this specification to describe soil reinforcement in the form of sheets of a polymeric material, typically but not necessarily of woven construction with transverse strands integrally connected with longitudinal strands in a grid-like pattern.

A first embodiment of the reinforced soil retaining wall system 10 of present invention is now described with reference to Figures 1 to 7, the reinforced soil retaining wall system 10 comprising a plurality of blocks 12 arranged in courses 14 to form a wall 16. Soil reinforcement is provided to the wall 16 using a plurality of lengths of strip

reinforcement 18 inserted in and extending from the blocks 12, the strip reinforcement 18 being buried under compacted backfill 20 either as each course 14 is laid or after construction of the wall 16.

With reference to Figures 1, 2(a) and 2(b), the blocks 12 used in accordance with a first embodiment of the reinforced soil wall system 10 comprise a front face 22, a rear face 24 spaced from said front face by a distance defining the depth of the block 12, opposing side surfaces 26 and 28 respectively, spaced from each other by a distance defining the width of the block 12, a top surface 30 and a bottom surface 32 spaced from the top surface 30 by a distance defining the height of the block 12. In use, the block 12 is positioned such that the front face 22 is directed towards the dredge side 34 of the wall 16 with the rear face 24 being directed towards the retained side 36 of the wall 16. The block 12 further comprises a passage 40 extending from a first opening 42 in the bottom surface 32 towards the top surface 30. The first opening 42 could equally be provided in the top surface 30. With reference to Figure 4, the passage 40 is configured to receive a first portion 44 of a length of strip reinforcement 18 used to stabilize the wall 16.

Figure 1 illustrates a wall 16 constructed using a plurality of layers of mortar 47 to secure the position of each block 12. For mortarless construction, the bottom surface 32 of the block 12 is provided with one or more guide slot(s) 50 extending from the first opening 42 of the passage 40 to the rear face 24 of the block 12. The guide slot 50 is configured to accommodate a second portion 46 of the length of strip reinforcement 18 in such a way that the bottom surface 32 of a block 12 provided in a subsequent course 14' is able to sit flush against the top surface 30 of a block 12 in an underlying preceding course 14". This is achieved by ensuring that the guide slot 50 is of sufficient depth to house the thickness of the length of strip reinforcement 18. The guide slot 50 also assists in general directional alignment of the strip reinforcement 18 towards the retained side 36 of the wall 16. A third portion 48 of the length of strip reinforcement 18 is not received within the block 12 but rather extends outwardly away from the rear face 24 of the block 12.

Where mortar is used in the construction of the reinforced wall retaining wall system 10, the guide slot 50 is entirely optional and need not be present. This is because the

second portion 46 of the strip reinforcement 18 can be housed within the layer of mortar 47. Thus where mortar is used, the first portion 44 of the length of strip reinforcement 18 is received within the passage 40 of the block 12, the second portion 46 of the length of strip reinforcement 18 is arranged to extend in coplanar alignment with either the top or bottom surface 30 or 32, respectively of the block 12 through the mortar layer 17, and the third portion 48 of the length of strip reinforcement 18 is arranged to extend outwardly from the rear face 24 of the block 12 to be secured in position substantially perpendicular to the wall 16 during backfilling and compaction.

It is to be understood that the passage 40 need not extend through the full height of the block 12 provided only that the length of strip reinforcement 18 is caused to bend through an angle, preferably through approximately a 90 degree angle in order to resist pull-out forces that are applied to the strip reinforcement 18 after backfilling and compaction which put the strip reinforcement 18 into tension. It is preferable that the passage 40 is substantially vertically oriented relative to the top or base surface 30 or 32, respectively of the block 12. For this reason, the strip reinforcement 18 is resiliently flexible allowing it to be bent into position through a 90 degree angle. It is preferable that the passage 40 be positioned towards the front face 22 of the block 12.

It is also to be understood that the length of strip reinforcement 18 is not directly mechanically coupled to the block 12. Its position is effectively secured during the backfilling and compaction operations. In use, the length of strip reinforcement 18 is inserted into block 12 through the first opening 42 in so that the first portion 44 is received within the passage 40 and bent in place so that the second portion 46 is accommodated within the guide slot 50 for mortarless construction or within a layer of mortar 47 for construction using cement mortar. If the passage 40 extends through the full height of the block 12 from the bottom surface 32 through to the top surface 30, the passage 40 terminates in a second opening 52 provided in the top surface 30. The length of strip reinforcement 18 may be threaded through the passage 40 through either the first opening 42 or the second opening 52.

The strip reinforcement 18 may be made from any other material known to be suitable for soil reinforcement applications, for example, galvanized steel strip, knitted high strength polyester yarn, strips of polymer textured fabric, or high density polyethylene.

Conveniently, each length of strip reinforcement 18 may be cut from a sheet of mesh reinforcement, for example, geomesh and accordingly need not comprise a single longitudinal section. The strip reinforcement 18 may equally comprise a plurality of longitudinal sections held together by a plurality of horizontal sections, provided only that the strip reinforcement 18 is still insertable in the passage 40. The length of the strip reinforcement 18 required to stabilize the wall 16 is directly proportion to the height of the wall 16 and should be at least 0.7 x height of the wall. For poor soil and heavier loads the strip reinforcement 18 should be longer and or the quantity greater.

The material of construction of the blocks is equally unimportant to the working of the present invention. Typically each block 12 would be constructed from concrete which is made from a mixture of cement, water and one or more types of aggregate(s). The blocks may equally be constructed of other materials known to be suitable for retaining walls including geopolymers, limestone or metal. The colour and/or texture of the blocks is also not important and may be varied by, for example, adding oxides to the concrete or geopolymer or changing the type of aggregate used for aesthetic appeal.

In order to facilitate a better understanding of the various aspects of the first embodiment of the present invention, a method of construction of a reinforced soil retaining wall using the blocks 12 will now be described in the context of mortared construction. It is to be understood that the reinforced soil retaining wall system 10 is equally adaptable to mortarless construction as described below with respect to a second embodiment of the present invention.

The first step is the preparation of the site and the laying of a level foundation 60. An area is excavated on the retained side of the wall 16 to accommodate the design length of the soil reinforcement 18 which will vary in direct proportion to the height of the wall 16 above the dredge line 38. Any surface vegetation or organics in the soil should be removed if it is intended to be used as part of the backfill 20. A trench is dug along the full length of the wall 16 and the foundation 60 is prepared using a simple concrete slab or formed using any suitable compactable granular material such as crushed stone, road base aggregate, gravel, or coarse sand. The foundation 60 should be level along the full length of the wall 16 for best results.

The base course 62 is then laid on the level foundation 60. As is the case for any wall constructed using blocks, it is important that the base course be laid with particular care as any irregularities in the laying of the base course will become exaggerated as the height of the wall increases for mortarless construction. This is less important when using mortar to construct the retaining wall as any irregularities in the laying of the base course can be corrected by adjusting the amount of mortar. To assist in correct placement of the base course blocks, a string line (not shown) or other suitable alignment guide such as a laser sight should be used to guide the positioning of the blocks. A level indicating device such as a spirit level (not shown) should be used to check the level of each block in both the front-to-back and side-to-side directions after placement. A rubber mallet or other suitable dead blow hammer may be used to help adjust the position of a given block relative to the string line or spirit level as required. Unevenness in the base course can be corrected if needed using a suitable level correction device, for example, one or more shims (not shown).

With reference to Figure 1, the base course 62 is laid such that the blocks are partially embedded below the dredge line 38. Partial embedment of the base course blocks provides reinforcement to the base course 62 to reduce the risk of erosion under the wall 16 at the dredge line 38. There is no requirement that any soil reinforcement be used to provide support to the base course 62 and accordingly, the blocks 12 of the present invention need not be used in the construction of the base course 62. Any suitably sized block may be used, including solid blocks if convenient. If hollow blocks are used in the construction of the base course 62, the cavities of the hollow blocks may be filled either with drainage aggregate or an impermeable material such as concrete or cement. When aggregate is used, this should be tamped down to ensure that the cavities are filled, taking care not to disturb the position of the blocks.

Once the base course 62 has been laid, a suitable infill soil is used as the backfill 20 placed behind the base course 62. The backfill 20 is then compacted using any suitable compaction device such as a hand tamper or a mechanical plate compactor such as a vibratory-plate compactor. Compaction should be carried out to applicable civil engineering compaction standards which may vary from country to country. It is considered to be a matter of routine to a person skilled in the art to appreciate the level of compaction required to achieve civil engineering certification of the completed

retaining wall.

The second and each subsequent course of blocks 12 apart from the final course 64 are constructed using the blocks 12 of the present invention. Prior to laying each subsequent course 14, any debris or surface material should be removed from the top surface(s) 30 of the blocks 12 of the preceding underlying course. This provides a smooth surface for the placement of the next course of blocks. It is further recommended to reset the string line for each course and use the spirit level in the manner described above to assist in correct alignment of the blocks 12. The bond of each subsequent course is generally set such that the vertical seams 66 are offset for maximum strength. It is to be understood that the blocks need not be placed in the stretcher bond arrangement.

With reference to Figure 5, a length of strip reinforcement 18 is threaded through the first opening 42 and up into the passage 40 such that the first portion 44 is received within the passage 40. The length of strip reinforcement 18 is then bent such that the second portion 46 is arranged to extend along the bottom surface 32 from the first opening 42 towards the rear face 24. A layer of mortar 47 is then applied and the block 12, with the length of strip reinforcement 18 inserted therein, is laid over the blocks 12 forming the preceding course 14. The third portion 48 of the strip reinforcement 18 extends outwardly from the block 12 in the direction of the retained side 36 of the wall 16. Backfilling and compaction to anchor the strip reinforcement 18 in place may be conducted either after each course 14 is laid or after the wall 16 has been completed and is conducted in an analogous manner as described above in relation to the laying of the base course 62.

Immediately prior to backfilling after each or all of the second and subsequent courses 14 have been laid, each of the third portions 48 of the lengths of strip reinforcement 18 is oriented so as to be approximately perpendicular to the wall 16 and in general coplanar alignment with respect to the top or bottom surface 30 or 32, respectively of the block 12. Each third portion 48 is then held in this position when covered with infill soil during the next backfilling and compaction operation. Advantageously, it is possible to use separate crews during the construction of the reinforced soil retaining wall system of the present invention – a block laying crew being responsible for

inserting the strip reinforcement 18 in the blocks 12 during laying thereof and an earth compaction crew being responsible for orienting the position of each of the third portions 48 during backfilling and compaction operations after the wall has been completed.

Additional courses 14 are laid in this manner until the wall 16 is of the required height. During backfilling and compaction, the weight of the backfill 20 behind the wall 16 may cause the wall to cant towards the dredge side 34. To offset this, each course 14 may be set back approximately 4 mm or more from the preceding course 14 towards the retained side 36 of the wall 16 so that the completed wall 16 cants back by 2% or more towards the retained side 36 prior to backfilling. After backfilling and compaction, the wall 16 is substantially vertical.

If desired the final course 64 may take the form of capping as illustrated in Figure 7, to give the wall a more aesthetically pleasing appearance. The capping 64 may be secured in position using a waterproof construction adhesive and is of solid construction to prevent water from entering the passages 40 provided in the blocks 12 that are used to construct the wall 16.

When the soil being retained has a low permeability such as clay, a layer of drainage aggregate 104 may be placed immediately adjacent the retained side 36 of the wall 16 to prevent a buildup of hydrostatic pressure against this side of the wall.

A second embodiment of the blocks of the present invention is illustrated in Figures 8 to 10 for which like reference numerals refer to like parts. In this embodiment the blocks 12 are provided with a plurality of cavities 72 (in this example, two such cavities are shown) each cavity 72 extending through the full height of the block 12 and able to serve the same function as the passage 40 of the block 12 described above in relation to the first embodiment. These blocks 12 are hereinafter referred to as "hollow blocks". One of the advantages of using hollow blocks 12 is that the effective weight of each block is lower than the weight of a block of solid construction of equivalent size, making the hollow blocks easier to carry, stack and lay. Another advantage is that the cavities 72 have a larger volume than the passage 40 of the first embodiment, making insertion of the length or lengths of strip reinforcement 18 into or through the

block 12 easier.

For mortarless construction, each of the hollow blocks 12 is provided with one or more guide slot(s) 50 which serve the same function as described above in relation to the first embodiment. Where mortar is used, the guide slot(s) 50 are not required. It is not necessary for a guide slot 50 to be provided for each of the cavities 72.
In order to facilitate a better understanding of the various aspects of the second embodiment of the present invention, a method of mortarless construction of a reinforced soil retaining wall using the hollow blocks 12 will now be described with reference to Figures 8 to 10. It is to be understood that the reinforced soil retaining wall system 10 is equally adaptable to construction using mortar in an analogous manner as described above with respect to the first embodiment of the present invention.

During construction of the wall 16 using the hollow blocks 12, the foundation 60 and the base course 62 are laid in an analogous manner to that described above in relation to the first embodiment. Backfilling and compaction is conducted after the base course 62 has been laid.

The second and each subsequent course of blocks 12 (apart from the final course 64) are constructed using the hollow blocks 12. With reference to Figure 9, a length of strip reinforcement 18 is threaded through one of the cavities 72 such that a first portion 44 is received within the cavity 72. The length of strip reinforcement 18 is then bent through substantially 90 degrees such that the second portion 46 is accommodated within the guide slot 50. The first portion 44 is positioned within the cavity 72 towards the front face 22 of the block 12 to provide maximum resistance to overturning forces on the wall 16.

When the hollow block 12 with the length of strip reinforcement 18 inserted is laid over the blocks forming the preceding course 14, the guide slot 50 is positioned towards the retained side 36 of the wall 16. As or after each new course is laid, the cavities 72 of the hollow blocks 12 are filled with a quantity of ballast 76 in the form of an impermeable material, for example, concrete, or a permeable material, for example, drainage aggregate. Where drainage aggregate is used, the material should be

tamped down within the cavity to ensure that no voids are left. The ballast 76 assists in providing stability to the wall, helps to retain the position of the strip reinforcement 18 relative to the cavity 72 and helps to resist movement of the blocks during the backfilling and compaction operations. The drainage aggregate also acts as a cushion to protect the strip reinforcement from damage that may occur if the strip reinforcement is allowed to come into contact with either of the rearward edges 78 of the cavity 72. Moreover, since concrete has poor bending strength, the aggregate helps to distribute the tensile forces acting on the strip reinforcement 18 over a greater surface area that the inside rear face 80 of the cavity 72.

After the hollow cavities 72 have been filled with the quantity of ballast 76, the wall 16 is backfilled using an appropriate infill soil and compacted in the manner described above in relation to the base course 62. Immediately prior to backfilling after the second or subsequent course 14 has been laid, the third portion 48 of the length of strip reinforcement 18 is oriented so as to be approximately perpendicular to the wall 16 and in general coplanar alignment with respect to the bottom surface 32 of the block 12. The third portion 48 is then held in this position when covered with infill soil either after each course 14 is laid or when the wall 16 has been completed.

With reference to Figures 9 and 10, this second embodiment differs from the first embodiment in that the effective length of the strip reinforcement 18 has been approximately doubled such that a fourth portion 74 of the strip reinforcement 18 extends from the first portion 44 which is received within the cavity 72. This fourth portion 74 is caused to drape over the dredge side 34 of the wall 16 during backfilling and compaction of the course 14 that has just been laid. During backfilling and compaction, the third and fourth portions 48 and 74 is laid over a layer of previously compacted soil and oriented so as to be approximately perpendicular to the wall 16 and in general coplanar alignment with respect to the top or bottom surfaces 30 or 32, respectively, of the hollow blocks 12.

Additional courses 14 are laid in this manner until the wall 16 is of the required height. If desired the final course 64 may take the form of capping as described above. Backfilling and compaction can be conducted after each course 14 is laid or after the wall 16 has been completed.

To provide additional resistance against shearing across adjacent courses 14 in the wall 16, the system 10 may further include a plurality of shear pins 82 illustrated in Figure 9, in the form of a plurality of rectangular blocks made of concrete and inserted into the cavity 72 prior to the cavity 72 being filled with the quantity of ballast 76. It is worth noting that the use of shear pins 82 is entirely optional in that it has been found that when coarse aggregate is used as the ballast 76, resistance to shear forces is provided by the particles of the coarse aggregate themselves. When the cavities 72 have been filled with coarse aggregate, movement of one block 12 in the wall 16 relative to an adjacent block in an adjacent course 14 would require displacement of the particles of coarse aggregate relative to each other. Because the drainage aggregate particles are generally of the same size, this is difficult to achieve, providing additional resistance to shear between adjacent courses.

It is equally possible although more cumbersome to thread the strip reinforcement 18 through a plurality of blocks 12 in adjacent courses 14 as illustrated in Figure 9. It should be noted that it is not necessary for every block 12 to be provided with a length of strip reinforcement unless large surcharge loads are anticipated. It is considered a matter of routine for a person skilled in the art to determine the requisite amount of strip reinforcement required for the particular material of construction of the wall, its height, the anticipated loads and the type of backfill being retained.

A third embodiment of the reinforced soil retaining wall system 10 and blocks 12 of the present invention is illustrated in Figure 11 for which like reference numerals refer to like parts. During construction at a building site, the retaining wall is often the first structure installed followed by other installations such as plumbing, electrical, foundations and the like. In this third embodiment, the system 10 comprises a composite wall 90 divided at a transition depth 92 into an upper section 94 and a lower section 96. The lower section 96 of the composite wall is a reinforced soil retaining wall 16 which is constructed in an analogous manner as described above in relation to either the first or second embodiments. The lower section 96 is laid with backfilling and compaction is carried out on the retained side 36 of the composite wall 90. The upper section 94 of the composite wall 90 is then constructed as a gravity wall having a height equal to the transition depth 92. The gravity wall 94 is constructed in

accordance with the practices of the background art.

The upper section 94 may equally take the form of a steel reinforced cantilever wall by positioning a plurality of steel bars (not shown) through the cavities 72 of the blocks used in the construction of the upper section 94 of the composite wall 90, the cavities 72 thereafter being filled with concrete to hold the steel bars in place. A plurality of shear pins 82 may be installed inside the blocks 12 in the uppermost course of the lower section 96 of the composite wall 90 at the transition depth 92 to provide resistance to shearing of the upper section 94 relative to the lower section 96.

This third embodiment was based on a realization that the top 0.1-0.9 meters of the retaining wall is effectively self-supporting. The transition depth 92 depends in part on the anticipated depth of any installations or structures to be constructed on the retained side of the wall, but it is anticipated that the transition depth will not exceed one metre and will more likely be around 0.4 to 0.6m below the final anticipated height of the composite wall 90.

A soil reinforcement protection barrier 98 may be installed at the transition depth 92 in general coplanar alignment with respect to the top surface 30 of the uppermost course 14 of the lower section 96. The barrier 98 serves as a visual or physical barrier to protect the strip reinforcement 18 from damage during subsequent building operations adjacent to the completed retaining wall. Accordingly, the barrier 98 may take the form of a thin planar strip of plastic that provides a visual indication that the transition depth has been reached during subsequent digging. Alternatively, the barrier 98 may take the form of a concrete slab which provides physical resistance to penetration during subsequent digging and providing additional protection to the strip reinforcement 18 below.

A fourth embodiment of the system 10 and blocks 12 of the present invention is illustrated in Figures 12 and 13 for which like reference numerals refer to like parts. This embodiment has been designed specifically to deal with problems associated with using backfill such as clay soils which have a very slow rate of permeation of water. As a result of the low permeability of the soil, the backfill 20 may become saturated over time, for example due to precipitation, resulting in a buildup in water being stored

on the retained side 32 of the wall 16. This causes hydrostatic pressure on the wall 16 to increase, effectively pushing against the retained side 32 of the wall 16.

One way to overcome this problem is to place a vertically oriented permeable layer 104 of permeable material such as drainage aggregate adjacent to the retained side 32 of the wall 16 to allow water to drain under gravity from behind the wall through a drainage channel 106 positioned towards the base of the wall 16 and extending from the permeable layer 104 to the dredge side 34 of the wall 16 above the dredge line 38. The drainage aggregate would typically consist of a plurality of stone particles of sufficiently large and common size to cause voids to exist between them to allow the passage of the water. The permeable layer 104 may be laid in sections as each course 14 is laid ensuring that the lengths of strip reinforcement 18 extend through the permeable layer 104 to be anchored in the backfilled and compacted soil 20 behind the permeable layer 104. The wall 16 is otherwise constructed in an analogous manner as described above in relation to any one of the earlier embodiments.

Drainage aggregate is easily dislodged by workmen during backfilling and compaction or laying operations and the block laying crew must clear any loose stones before laying the next course of blocks. In addition, the permeable layer 104 is not self supporting and this can result in a thicker layer being used than would otherwise be required leading to increased materials and installation costs.

To alleviate this potential problem, the hollow blocks of the second embodiment are particularly suited for use with clay soils. If the cavities 72 are filled with drainage aggregate, the wall itself can serve the function of the permeable layer 104 with the guide slot(s) 50 provided in each hollow block 12 serving the function of a plurality of drainage channels 106 each directing water from the retained side 36 of the wall 16 into the cavities 72 filled with drainage aggregate. In this embodiment, the blocks 12 used in the construction of the base course 62 are inverted such that the guide slot(s) direct water from the permeable layer 104 towards the dredge side 34 of the wall 16 to allow the water to drain out of the wall itself.

The size and configuration of the guide slot(s) 50 may be varied to suit the maximum predicted rainfall for a given geographical location to drain from the retained soil at a

rate faster than the known flow capacity of the retained backfill 20. The accumulated liquid inside the permeable layer 104 defined by the filled cavities 72 of the hollow blocks 12 generates a head of pressure that encourages the flow of liquid out through the guide slots 50 of the inverted blocks 12 forming the base course 62.

It is to be understood that the base course 62 in this fourth embodiment need not be constructed using inverted hollow blocks 12 and could equally be constructed using the solid blocks of the first embodiment or any other type of solid block provided only that the wall 16 is provided with at least one drainage channel 106 of a suitable size to direct the flow of liquid from within the permeable layer 104 towards the dredge side 34 of the wall 16.

A fifth embodiment of the system 10 and blocks 12 of the present invention is illustrated in Figure 14, for which like reference numerals refer to like parts. As briefly described above in relation to the first and second embodiments, each length of strip reinforcement 18 is directly proportional to the height of the anticipated final height of the wall 16. This can make threading of the strip reinforcement 18 through a through-thickness passage 40 or the cavity 72 difficult to achieve for walls that are high, particular for walls higher than around 1.6 metres. It is not only the threading of the strip reinforcement 18 through the cavity 72 or passage 40 of each block 12 that becomes increasingly difficult as the height of the wall 16 increases, but also the general handling of long lengths of strip reinforcement 18 which has the tendency to curl and may snag more readily when trying to lay each course 14 of the blocks 12.

This problem is overcome in this fifth embodiment by splitting the length of strip reinforcement into a short threaded section 100 and a longer free section 102. Each short threaded section 100 is inserted through the block 12 in an analogous manner as described above in relation to any one of the first three embodiments. The longer free section 102 is then laid separately during the backfilling and compaction operations either after each course 14 has been completed or after the wall 16 has been completed. Each free section 102 may be fixedly attached to a corresponding threaded section 100 or laid so as to extend substantially perpendicularly away from the wall 16 on the retained side 32 at any depth within the backfill 20.

After backfilling and compaction, the combined effect of laying the free section 102 separately and/or interdependently of the threaded section 100 is the same as laying one continuous length of strip reinforcement 18, provided only that the free section 102 extends away from the retained side 32 of the wall 16 at least through the anticipated plane of rupture 108 of the backfill 20. The plane of rupture 110 runs at an angle β relative to the dredge line 38 of the wall 16, the angle β being the Rankin angle (or angle of internal friction) which is a function of the type of backfill 20 being retained.

A further advantage of using this embodiment, even for shorter walls is that it allows for separate crews to be used – a block laying crew being responsible for inserting the threaded sections 100 in the blocks 12 and an earth compaction crew being responsible for laying the free sections 102 during backfilling and compaction.

It has further been realized that the threaded and free sections 100 and 102 need not be provided in the form of lengths of strip reinforcement 18 but may equally be provided using grid or sheet reinforcement, for example, geomesh. Figure 15 thus illustrates a reinforced soil retaining wall system 110 for which like reference numerals refer to like parts. The blocks 112 of this embodiment may be any standard type of block used for the construction of a reinforced soil retaining wall or the blocks 12 described above for any of the first to fifth embodiments. The reinforced soil retaining wall system 110 comprises a first plurality of sections of soil reinforcement 114 for anchoring the wall 16 to the backfill 20, the first plurality of sections of soil reinforcement 114 arranged between adjacent courses 14' and 14" of the wall 16 and extending outwardly from the rear face 24 of the blocks 112 on the retained side 36 of the wall 16. In the embodiment illustrated in Figure 15, the first plurality of sections of soil reinforcement 114 take the form of short sections of geomesh. With reference to Figure 14, it is to be understood that the first plurality of sections of soil reinforcement 114 could equally be provided using elongate strips such as the threaded sections 100 illustrated in Figure 14 and that the elongate strips need not be threaded through the blocks, provided only that they are arranged between adjacent courses 14' and 14" and extend outwardly from the rear face 24 of the blocks 12 on the retained side 36 of the wall 16.

The reinforced soil retaining wall system 110 further comprises a second plurality of

sections of soil reinforcement 116 for stabilizing the backfilled and compacted soil on the retained side 36 of the wall 16, the second plurality of sections of soil reinforcement 116 being spaced apart from the first plurality of sections of soil reinforcement 114 and arranged to extend substantially perpendicular to the wall 16 during backfilling and compaction. With reference to Figure 15, the second plurality of sections of soil reinforcement 116 are provided in the form of large planar sheets of geomesh which are spaced apart from the first plurality of sections of geomesh 114. Whilst geomesh is preferred, other types of soil reinforcement may be used with suitable materials being those that are resistant to aging in the particular soil environment and which have sufficient tensile strength to carry the anticipated loads in use.

In Figure 15, the second plurality of sections of soil reinforcement 114 is positioned immediately adjacent to the retained side 36 of the wall 16. It is to be understood that the second plurality of sections of soil reinforcement 114 could equally be spaced apart from the rear face 24 of the blocks 112 on the retained side 36 of the wall 16.

In the embodiment illustrated in Figure 15, the first and second plurality of sections of soil reinforcement 114 and 116, respectively are arranged in horizontal coplanar arrangement with respect to each other with the first plurality of sections of soil reinforcement 116 being arranged in a first layer 118 and the second plurality of sections of soil reinforcement 116 are arranged in a second layer 120 offset from the first layer 118. The spacing between the first and second layers 118 and 120 respectively may vary depending on a number of factors but would generally not be expected to exceed one metre.

The first plurality of sections of soil reinforcement 114 are arranged in coplanar alignment with the top or base surface 30 or 32, respectively of one or more of the plurality of blocks 112 immediately prior to backfilling and compacting. The second plurality of sections of soil reinforcement 116 need not be arranged in coplanar alignment with the top or base surfaces 30 or 32, respectively, but could equally be arranged in alignment with a plane 122 that intersects the block 112 at a height intermediate between the top and base surfaces 30 or 32.

The first plurality of sections of soil reinforcement 114 may be fixedly held between

adjacent courses 14' and 14" of blocks 112 using mortar or held by gravity under the natural weight of the blocks forming the courses above.

Depending on a number of factors including the type and quality of the soil used for the backfill 20, the length of the second plurality of sections of soil reinforcement 114 may be equal to at least 60%, 70% or 80% of the height of the wall 16 and should extend through at least the anticipated plane of rupture 108 of the backfill 20. It is considered to be a matter of routine to a person skilled in the art to determine the quantity and length of second plurality of sections of soil reinforcement 114 required for a particular application depending on such factors as the slope stability, the angle of internal friction β of the soil, soil cohesion and the moist unit weight of the soil as well as such factors as the height of the wall, any surcharge loads and the top slope angle. For example, for poor quality soil, a larger quantity of the second plurality of sections of soil reinforcement 114 may be required to provide sufficient stability to the wall. Where a larger quantity is used, the tensile strength of each individual section need not be as great as less load is carried by each individual section.

As illustrated in Figure 15, the wall 16 may be constructed using the hollow blocks described above with respect to the second embodiment with the exception that the guide slots 50 are not required. The cavities 72 of the hollow blocks 112 are configured to receive a quantity of ballast 76 as described above, the ballast 76 being either drainage aggregate or an impermeable material such as concrete added to the cavities 72 apart the blocks 112 have been laid. One or more shear pins 82 may be provided to resist sliding movement of a first course 14' over an adjacent second course 14" if desired. A drainage channel 106 configured to direct moisture from the retained side 36 of the wall 16 towards the dredge side 34 of the wall 16 may also be provided if desired and is particular advantageous when the backfill 20 is a clay soil in order to relieve hydrostatic pressure that may otherwise be exerted on the wall 16. The reinforced soil retaining wall system 110 is equally adaptable for construction as a composite wall 90 in an analogous manner as described above.

One embodiment of the method of construction of a reinforced soil retaining wall 110 is now described with reference to Figure 15 in the context of mortarless construction. It is to be understood that the reinforced soil retaining wall system 110 is equally

adaptable to mortared construction, the mortar being used in part to secure the position of the first plurality of sections of soil reinforcement 114 between adjacent courses 14.

A foundation 60 and base course 62 are laid in an analogous manner as described above. Once the base course 62 has been laid, a suitable infill soil is used as the backfill 20 placed behind the base course 62 and compacted to applicable civil engineering compaction standards which may vary from country to country. Before a subsequent course is laid, a first plurality of sections of soil reinforcement 114 for anchoring the wall 16 to the backfill 20 is arranged along the top surfaces 30 of the blocks 112 forming the base course 62. The first plurality of sections of soil reinforcement 114 are arranged to extend outwardly from the rear face 24 of the blocks 112 on the retained side 36 of the wall 16. It is to be understood that first plurality of sections of soil reinforcement 114 need not extend along the full length of the wall 16 and need not be provided between each of the adjacent courses 14 forming the wall 16. Using mortarless construction, the first plurality of sections of soil reinforcement 114 are held in place by the weight of the next course of blocks laid over the top of them. Where mortar is used, the layers of mortar 47 assist in retaining the position of the first plurality of sections of soil reinforcement 114 prior to backfilling.

The second plurality of sections of soil reinforcement 116 are laid during backfilling and compaction which may be conducted either after each course 14 is laid or after the wall 16 has been completed and is conducted in an analogous manner as described above in relation to the laying of the base course 62. The second plurality of sections of soil reinforcement 116 are arranged in such a way that they are spaced apart from the first plurality of sections of soil reinforcement 114 and extend substantially perpendicular to the wall 16 during backfilling and compaction of a quantity of backfill 20 behind the rear face 24 of the blocks 112 so as to anchor the position of the first and second plurality of sections of soil reinforcement 114 and 116, respectively. Additional courses 14 are laid in this manner until the wall 16 is of the required height.

If desired, the final course 64 may take the form of capping as illustrated in Figure 7, to give the wall a more aesthetically pleasing appearance. When the soil being retained has a low permeability such as clay, a layer of drainage aggregate 104 may be placed

immediately adjacent the retained side 36 of the wall 16 to prevent a buildup of hydrostatic pressure against this side of the wall.

If hollow blocks are used to construct the wall 16, the method of construction further comprises the step of adding a quantity of ballast 76 to the cavities 72 either after each block or each course of blocks has been laid in an analogous manner as described above with reference to the second embodiment. Where shear pins 82 are used to resist sliding movement of a first course 14' over an adjacent second course 14", the placement thereof should not interfere with the placement of the first plurality of sections of soil reinforcement 114. Accordingly, shear pins 82 may be provided between every second course 14 of blocks 112 with the first plurality of sections of soil reinforcement 114 being provided between the remaining courses.

Now that the preferred embodiments of the present invention have been described in detail, the present invention has a number of advantages over the prior art, including the following:

a) lightweight hollow blocks permit rapid installation and reduce the likelihood of work-related injury to the block laying crew;

b) the strip reinforcement is not mechanically coupled to the blocks thereby reducing the component cost of the block as well as the labor time associated with installing the blocks. This also reduces the opportunity for incorrect attachment of the reinforcement to the facing block;

c) the blocks may be manufactured in a standard rectangular shape and laid in a standard interlocking brick pattern which increases the aesthetics of the wall and also increases its strength. The block can be cheaply and readily mass produced as there is no need to incorporate mechanical fasteners into the blocks; and,

d) the system requires no direct mechanical attachment of the strip reinforcement to the blocks which allows for plastic to be used instead of galvanized steel which reduces the material costs. Using prior art methods, holes were needed in the strip reinforcement which made the use of plastics impermissible as most plastic materials have poor resistance to tearing.

It will be apparent to persons skilled in the relevant art that numerous variations and

modifications can be made without departing from the basic inventive concepts. For example, the front face of the block need not be planar but can be provided with a different shape or surface texture on the dredge side of the wall. Similarly, the wall system could further include a protective or decorative facing panel (not shown) applied to the dredge side of the wall to alter the aesthetic appeal thereof after construction. Whilst in all of the illustrated embodiments, a single length of strip reinforcement has been inserted per block, it is equally permissible for a plurality of lengths of strip reinforcement to be placed in a passage or cavity of a single block. The present invention is equally applicable to the construction of a tiered retaining wall by building a plurality of walls, each upper wall set back from an underlying wall. Tiered walls can be attractive alternatives to single tall walls and can provide areas for plantings. To prevent an upper wall from placing a load on a lower wall, the upper wall should be built behind the lower wall a distance of at least twice the height of the lower wall. All such modifications and variations are considered to be within the scope of the present invention, the nature of which is to be determined from the foregoing description and the appended claims.